APPARATUS AND METHOD FOR TRANSMITTING TERRESTRIAL SIGNALS ON A COMMON FREQUENCY WITH SATELLITE TRANSMISSIONS

INVENTORS:

CARMEN TAWIL AND SALEEM TAWIL

"Express Mail" Mailing label number EL533564476US
Date of Deposit: November 16, 2000
I hereby certify that this paper or fee is being deposited with the United States Postal Services "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Box CPA, Washington, DC 20231

Reg. No. 32,124, Russell D. Culbertson ______________________

APPARATUS AND METHOD FOR TRANSMITTING TERRESTRIAL SIGNALS ON A COMMON FREQUENCY WITH SATELLITE TRANSMISSIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of application serial number 08/991,265 filed December 16, 1997 and currently pending which was a continuation of application serial number 08/731,244, filed October 11, 1996, now U.S. Patent No.5,761,605.

BACKGROUND OF THE INVENTION

This invention relates to devices and methods for broadcasting and receiving data, including digital television signals and voice signals. More particularly, this invention relates to an apparatus and method for providing terrestrial transmissions simultaneously along with direct broadcast satellite transmissions on a common frequency.

Currently, television signals may be received from a satellite in geosynchronous orbit about the earth. The television signals are transmitted from a terrestrial transmitter to the satellite and then retransmitted from the satellite so that the signals can be received by terrestrial receivers within a certain geographic receiving area within a line of sight of the satellite. In addition to television signals, other types of data may also be transmitted to consumers through satellites in geosynchronous orbit.

Direct broadcast satellite service (DBS) refers to satellite transmission of television signals directly for use by individual households or subscribers having the proper signal receiving equipment. The U.S. Federal Communications Commission has dedicated the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting.

Numerous signal carriers are located within the DBS spectrum, each carrier carrying several individual television channels. Depending upon the compression technology applied to these signals, literally hundreds of separate channels may be available through DBS. A great benefit of the DBS system as opposed to prior satellite systems is that only a small dish-type antenna is required to receive the DBS signals and the alignment of the receiving dish is not critical. Also, the DBS system will provide high quality reception at any point in the geographic receiving area of a satellite without the expense of land transmission lines such as those required for cable television.

Current regulations require that DBS satellites be separated from each other by at least nine (9) degrees in a geosynchronous arc. The receiving antenna for DBS signals must, therefore, be limited to receiving signals in a directional range measuring plus or minus nine (9) degrees from a centerline of the antenna. Receiving signals in a range wider than the satellite spacing would cause interference by signals transmitted by different satellites on the same frequency.

U.S. Patent No. 5,483,663 is directed to a system having a receiver arrangement in which DBS and terrestrial signals are received within similar frequency bands. The system shown in the 5,483,663 Patent may be implemented with a multiple antenna arrangement, or with a single, moveable antenna. In the multiple antenna arrangement, two separate antennas direct the received signals to a common propagation path for processing as if they were received by a single antenna and transmitted from a single location. In the single antenna arrangement, the antenna is movable between a position to receive DBS signals and another position to receive terrestrial signals.

The advantage of the system shown in U.S. Patent No. 5,483,663 is that local originating signals, whether television signals or other data, may be received simultaneously with DBS signals, and processed with the same equipment as that used to process the DBS signals. The local originating signals may carry local programming which may be received along with the national or regional DBS programming.

However, since the signals received in the system shown in U.S. Patent No. 5,483,663 are combined or received on the same antenna structure at different points in time, terrestrial and DBS signals on a common frequency cannot be utilized simultaneously.

SUMMARY OF THE INVENTION

It is an object of the invention to provide terrestrially transmitted signals simultaneously with satellite transmitted signals at the same frequency. The invention includes an apparatus and method for providing terrestrial signals simultaneously at a common frequency with satellite signals.

The object of the invention is accomplished by utilizing receiving antennas with a limited directional reception range and transmitting the terrestrial signals in a different range of directions than those in which the satellite signals are transmitted. Two separate receiving antennas feeding two sets of decoding and demodulating processing systems are required for utilizing the received signals. Both receiving antennas are adapted to receive signals only within a particular directional range. The range is measured from a centerline of the particular antenna.

In order to ensure no interference between the satellite and terrestrially transmitted signals, the terrestrial signals are transmitted directionally within a terrestrial azimuth range which is outside the azimuth range in which the satellite signals are transmitted either by a single satellite or multiple satellites. The terrestrial transmission azimuth range is chosen so that it does not include any directions in which the satellite signal receiving antenna must be directed to receive signals from any satellite. In order to cover a large area for local reception, a plurality of terrestrial transmitters are spread out over an area with directional transmission areas overlapping to ensure the terrestrial signals may be received clearly at each location within the desired service area.

These and other objects, advantages, and features of the invention will be apparent from the following description of the preferred embodiments, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic representation showing the positions of a plurality of satellites in relation to a single terrestrial transmitter and a receiver or user location.

FIGURE 2 is a somewhat schematic representation of a receiving antenna structure for receiving satellite and terrestrial transmitted signals at a common frequency.

FIGURE 3 is a schematic representation of the spacing for a number of terrestrial transmitters required to allow reception over a large geographic area.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus according to the invention for providing terrestrially transmitted signals simultaneously on the same frequency as satellite signals is illustrated in FIGURES 1 and 2. As shown in FIGURE 1, the system 10 may be utilized with one or more satellites in geosynchronous orbit about the earth. FIGURE 1 shows four satellites 12a, 12b, 12c, and 12d spaced apart at four separate directions from a user location 14. In geosynchronous orbit, each satellite remains at a fixed location with respect to the earth's surface, and thus, with respect to the user location 14. First and second antenna 16 and 18, respectively, which will be discussed in detail with reference to FIGURE 2 are located at the user location 14.

Each of these satellites 12a-d is positioned in geosynchronous orbit about the center of the earth, and is positioned at a certain longitude and latitude above the earth's surface. As is known by those skilled in the art, a receiving antenna may be directed at a certain elevation and direction or azimuth toward a desired satellite location for receiving signals from the particular satellite.

Currently, all direct broadcast satellites within the line of sight of North America are positioned at longitudes and latitudes requiring the receiving antenna to face in a southerly direction from North America to receive signals. Although FIGURE 1 shows four satellites 12a-d for purposes of describing the invention herein, more or fewer satellites may be spaced apart within a line of sight of a certain geographical area. Several satellites are currently within a line of sight of North America. Table 1 sets out the longitudinal location of each satellite and for purposes of example, the azimuth and elevation at which a receiving antenna

must be directed from a location at Austin, Texas for receiving signals from each satellite. All azimuth directions and elevations are measured to a centerline of the antenna which will be discussed below with respect to FIGURE 2. The term "azimuth" refers to the direction with respect to a reference direction such as due north, commonly zero degrees. "Elevation" refers to the angle of the antenna centerline above horizontal.

TABLE I

Satellite Longitude	Azimuth	Elevation
61.5	124.5	37.3
101	186.4	54.6
110	203.3	52.3
119	217.7	47.8
148	247.3	25.7
157	253.3	17.9
166	258.8	10.1
175	263.5	2.3

DBS satellites all transmit different signals in the same frequency band. The U.S. Federal Communications Commission has set aside the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. In order to ensure no interference from signals between two adjacent satellites, two conditions must be met. First, the receiving antenna must be limited to receive signals only within a certain reception range about the centerline of the antenna. Secondly, the satellites must be spaced apart about the

geosynchronous arc so that a receiving antenna may be positioned with only a single satellite transmitting in the directional reception range of the antenna.

According to current regulations, individual DBS satellites must be separated at least nine (9) degrees in the geosynchronous arc. Thus, each DBS receiving antenna must have a directional reception range or aperture of plus or minus nine (9) degrees or less as measured from a centerline of the antenna. Although current regulations require a spacing of no less than nine (9) degrees separation, the invention is not limited to this degree of separation. However, according to the invention, the effective reception range of each first antenna or satellite reception antenna must be less than or equal to the minimum satellite separation angle.

FIGURE 1 also shows a terrestrial transmitter 20 capable of transmitting in one or more frequencies identical to a frequency transmitted by one of the DBS satellites. The terrestrial transmitter 20 transmits directionally within a certain transmission range T. The transmission range T shown in FIGURE 1 is 180 degrees, although the range may be more or less than this number.

The antenna structure 22 which may be used at user location 14 (FIGURE 1) to pick up signals transmitted according to the invention is illustrated in FIGURE 2. The first antenna 16 is designed to receive direct broadcast satellite signals. The first antenna 16 includes a collecting dish 24 and a feed-horn assembly 26 for receiving the signals reflected and concentrated by the dish. Those skilled in the art will readily appreciate that the feed-horn assembly 26 includes a probe, which is not shown in FIGURE 2, for picking up the signal received by the antenna. The probe feeds the signal to signal processing equipment for extracting information from the received signal. This signal processing equipment is well

known in the art and does not form a part of this invention. Also, those skilled in the art will appreciate that numerous types of assemblies may be used alternatively to the feed-horn assembly 26 for collecting signals reflected by the dish 24.

The first antenna 16 includes an antenna centerline 28. The total reception range for antenna 16 shall be referred to in this disclosure and the accompanying claims as the "satellite" or "first" directional reception range, and is equal to two times the reception range d max measured from the antenna centerline 28. Signals propagating in a direction outside of this satellite directional reception range or aperture about the antenna centerline 28 from user location 14 cannot be received by the first antenna 16.

Referring still to FIGURE 2, the antenna structure 22 at the user location 14 further includes the separate second antenna 18 for receiving the terrestrially transmitted signals. The second antenna 18 is shown as a feed-horn type antenna, however, those skilled in the art will readily appreciate that the second antenna may include a circular wave guide antenna, flat plate antenna, slot antenna, dipole antenna or multi-dipole antenna. Regardless of the antenna type, the antenna will include a suitable signal pick-up assembly for picking up the signal received by the antenna and feeding the signal to suitable signal processing equipment. This processing equipment is separate from the processing equipment for processing the signals received by the first antenna 16. Also, although the second antenna 18 is shown connected to the same structure as the first antenna 16, the first and second antennas may be completely separate. In any event, the second antenna 18 is preferably rotatable about a vertical axis as shown at B in FIGURE 2 to direct the antenna for optimally receiving the terrestrial transmitted signals.

As with the first antenna 16, the second antenna 18 includes a centerline 30 and may receive signals travelling only within a directional reception range r max. about the antenna centerline 30. The total reception range for second antenna 18 shall be referred to in this disclosure and the accompanying claims as the "terrestrial" or "second" directional reception range, and is equal to two times the reception range r max. Signals traveling to user location 14 along a route outside that terrestrial directional reception range cannot be received by the second antenna 18.

Referring again to FIGURE 1, the first antenna 16 according to the invention, is directed to receive signals from one of the satellites, satellite 12d for example. The azimuth and elevation at which the first antenna 16 must be directed for optimally receiving signals from satellite 12d may be 247.3 and 25.7 respectively, for example. The second antenna 18 is directed with its centerline 30 pointing generally to the terrestrial transmitting location of the terrestrial transmitter 20 and essentially horizontally. Ignoring the elevation difference between the first and second antennas 16 and 18, respectively, the azimuth difference between the centerlines 28 and 30 of the two antennas and this example is approximately 67.7 degrees.

In the orientation shown in FIGURE 1, the first antenna 16 cannot receive signals from the terrestrial transmitter 20. The reason for this is that the directional signals transmitted from the terrestrial transmitter 20 are all travelling in a direction or along a route outside of the satellite directional reception range of the first antenna 16. Similarly, the direction in which the satellite 12d transmits with respect to the user location 14 is outside of the terrestrial directional reception range of the second antenna 18. Thus, the second antenna 18 cannot receive signals transmitted by the satellite 12d. Furthermore, in this example, the second

antenna 18 cannot receive any signals transmitted by any of the satellites 12a-d. Thus, in the orientation of the first and second antenna 16 and 18 as shown in FIGURE 1 and with the position of the satellites 12a-d and terrestrial transmitter 20, the terrestrial transmitter may transmit on a frequency identical to the frequency of signals transmitted by the satellites without any interference in the signals received at the two antennas.

Those skilled in the art will readily appreciate that the elevation of the first antenna 16 may be high enough with respect to horizontal so that the second antenna 18 may be aligned along the same azimuth as the first antenna without any interference between the signals received by the two antennas on the identical frequency. However, where there are numerous satellites at different azimuths and elevations with respect to the user location 14, the first and second antennas 16 and 18 may have to be positioned at different azimuths as illustrated in FIGURE 1 in order to prevent interference.

Referring to FIGURE 3, a plurality of terrestrial transmitters 32 are required to provide a signal strong enough to be received over a large area. Each transmitter 32 in FIGURE 3 transmits directionally in an azimuth range A of approximately 180 degrees and out to an effective reception range R. With this transmitter spacing and transmission range, the signals from the terrestrial transmitters may be received from any location within the geographic area G. Although the directional range of 180 degrees is shown for purposes of example, the terrestrial transmissions may be in other ranges within the scope of this invention.

The method according to the invention is used in situations in which satellite signals are being transmitted in a first frequency for reception with the first antenna 16. The first antenna 16 is adapted to receive signals only within the satellite directional reception range about the

antenna centerline 28. The method includes transmitting signals at the first frequency directionally in a range outside of the satellite directional reception range of the first antenna 16. Signals transmitted by the terrestrial transmitter are received by the second antenna 18 at the user location 14. The second antenna 18 is adapted to receive signals only within the terrestrial directional reception range about the antenna centerline 30.

This directional terrestrial transmission according to the invention allows terrestrial transmission at an identical frequency as that used by satellites, and particularly DBS without interference between the two transmissions. This allows the DBS spectrum and perhaps other satellite spectra to be reused for terrestrial transmissions. The terrestrial transmissions may be for television signals or any other data, including internet communications, voice data, other video, or any other type of data.

The above described preferred embodiments are intended to illustrate the principles of the invention, but not to limit the scope of the invention. Various other embodiments and modifications to these preferred embodiments may be made by those skilled in the art without departing from the scope of the following claims.